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Editorial

Creative Systems

Computing research and industry has been working for decades to make computer applications robust and deterministic. Millions have been invested in improving software predictability and in strengthening its immunity to environment deviations and noise. Where some sort of innovation is required, the computer's job is typically confined to the problem of solving the task at hand and its creative aspects are entrusted to human intervention.

Surprising answers are highly valued in important classes of applications where huge spaces of possibilities are to be explored in divergent ways, obtaining innovative solutions. Novelty is a key issue in domains like scientific discovery, natural language generation, technical design and arts, to name a few. Motivation exists, thus, to investigate ways of giving computers the ability to exhibit some kind of autonomous creative behaviour.

Creativity is one of the most remarkable characteristics of the human mind. Its study has been a challenge for many scientists and researchers, particularly in areas such as Cognitive Science, Psychology, Education and Philosophy. A consolidated record of research, dating back to the beginning of the 20th Century (e.g., [1,2]) and the landmark work by Guilford's on the *Structure of Intellect* [3], support current views of creativity as a general ability and fundamental trait of human intelligence.

In recent years, research on creative systems attracted a growing number of AI researchers who have been working towards the proposal of abstract explanation theories, adequate computational models, and applications. One of the most important pushes to this dynamics was Boden's book *The Creative Mind* [4]. Other factors simultaneously stimulated and were a reflex of the development of a research field in computational creativity. The institution of regular events and the active presence of the topic in the main AI conferences are important examples of this. The Conferences on Computational Models of Creative Design occur on a regular basis since 1989. In 1999, the AISB Convention was devoted to creativity; a series of annual AISB symposia on AI and Creativity in Arts and Science started in 2000. Also in 2000, the presidential address at AAAI was about "Creativity at the Meta-Level". In 2001, the first Workshop on Creative Systems was held at ICCBR; subsequent editions were run at ECAI 2002 and IJCAI 2003. In 2004, this workshop series merged with the AISB series of symposia into the Workshop on Computational Creativity, held at ECCBR 2004, IJCAI 2005 and ECAI 2006. The more specific EvoMusArt workshop has been organised in the EuroGP conferences since 2003. In Europe, a Working Group on Computational Creativity, running from 2001 to 2003 in the EU-funded COST action 282 (Knowledge Exploration in Science and Technology), has also contributed to the consolidation of a research community in the field.

The idea for this Special Issue on "Creative Systems" was originated in the third Workshop on Creative Systems held in Acapulco, Mexico, at IJCAI 2003. During two days, various approaches to creativity were the subject of intense and productive discussions initiated by paper presentations, discussion panels and an invited talk by Stephen Muggleton. The papers, accepted after a blind and anonymous peer review, were organised into four topics: models of creativity, analogy and metaphor in creative systems, multiagent systems and formal approaches to creativity. Important theoretical contributions arose, together with practical developments, showing that a consolidated research community was emerging, with its own agenda and goals.

The editors of this special issue, who were co-chairing the workshop, early decided that this edition would make notice of current trends, challenges and opportunities for research on creativity to a broader community of AI and Cognitive Science researchers, and to stimulate the development of further research work in the field by congregating a set of topics simultaneously wide and fairly matured. The articles to include should represent a coherent collection, with very high quality standards.

The special issue should also represent much more than mere workshop proceedings. Opportunity should be given to the authors for making significant improvements and updates to their papers, taking the results of the discussions into consideration and not rigidly restricting the scope of their contributions to what had been presented in the workshop.

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Invitations for submission were issued to all the authors of papers accepted for presentation in the workshop. Each one of the nine received submissions was subject to peer review by two or three distinguished researchers and judged on significance, originality, quality and clarity. At the end, four articles were selected and subject to final adjustments and rewritings according to the reviewers' recommendations.

The first of these articles presents a formal framework for creative systems. The other three describe and evaluate systems for:

(i) Generation of new terms by a concept blending mechanism;
(ii) Creation of new categories or types in a system for linguistic creativity;
(iii) Creative generation of new software designs.

All these articles have a common aim of characterizing and establishing computational models of creativity.

The opening article by Geraint Wiggins proposes a formal framework for the description, analysis and comparison of creative systems, built on the analytical model proposed by Margaret Boden [4]. After addressing some terminological issues, the author presents a formalisation of the most significant concepts proposed by Boden and progressively elaborates his model. The distinction between exploratory and transformational creativity, one of Boden's proposals that has been the focus of much debate in the field, is one of the issues addressed in a formal way, which hopefully will contribute to clarify terminology. The analytical power of the formalisation is then illustrated by using it to describe important properties of creative systems.

The article by Francisco Pereira et al. presents Divago, a system for generation of new concepts from existing knowledge, and discusses a set of experiments made with it. The system is built on mechanisms of conceptual blending to produce new concepts with an emergent structure of their own. It resorts to structural alignment to establish mappings between distinct knowledge domains and employs a genetic algorithm to explore the space of possible analogical projections. The assessment of Divago's creativity is made in terms of novelty and usefulness, and is carried out over a large dataset built for another system, C^3 [5], which motivates a comparative analysis between both.

The role of metaphor and analogy in linguistic creativity is the focus of the next article, by Tony Veale. He describes and evaluates a process of ad hoc category and term creation within a conceptual system structured around a central taxonomy and elaborates on the role of creative metaphors and analogies. He concludes by stressing how analogy can help recognize the similarity between concepts that are apart in an ontology that otherwise would be considered unrelated. Veale illustrates his points on a system supported on the WordNet semantic lexicon.

The last article, by Paulo Gomes et al., addresses the importance of analogical reasoning on creative design. He describes REBUILDER, a computer aided software engineering tool, and the role of its analogical retrieval module on the generation of creative design solutions. In this system, semantic and structural analogies are used for retrieval of previous design cases. The article analyses the solutions produced by these two mechanisms concerning novelty and usefulness criteria. From these experiments, considerations are made on semantic and structural retrieval strategies and the trade-off between novelty and usefulness.

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